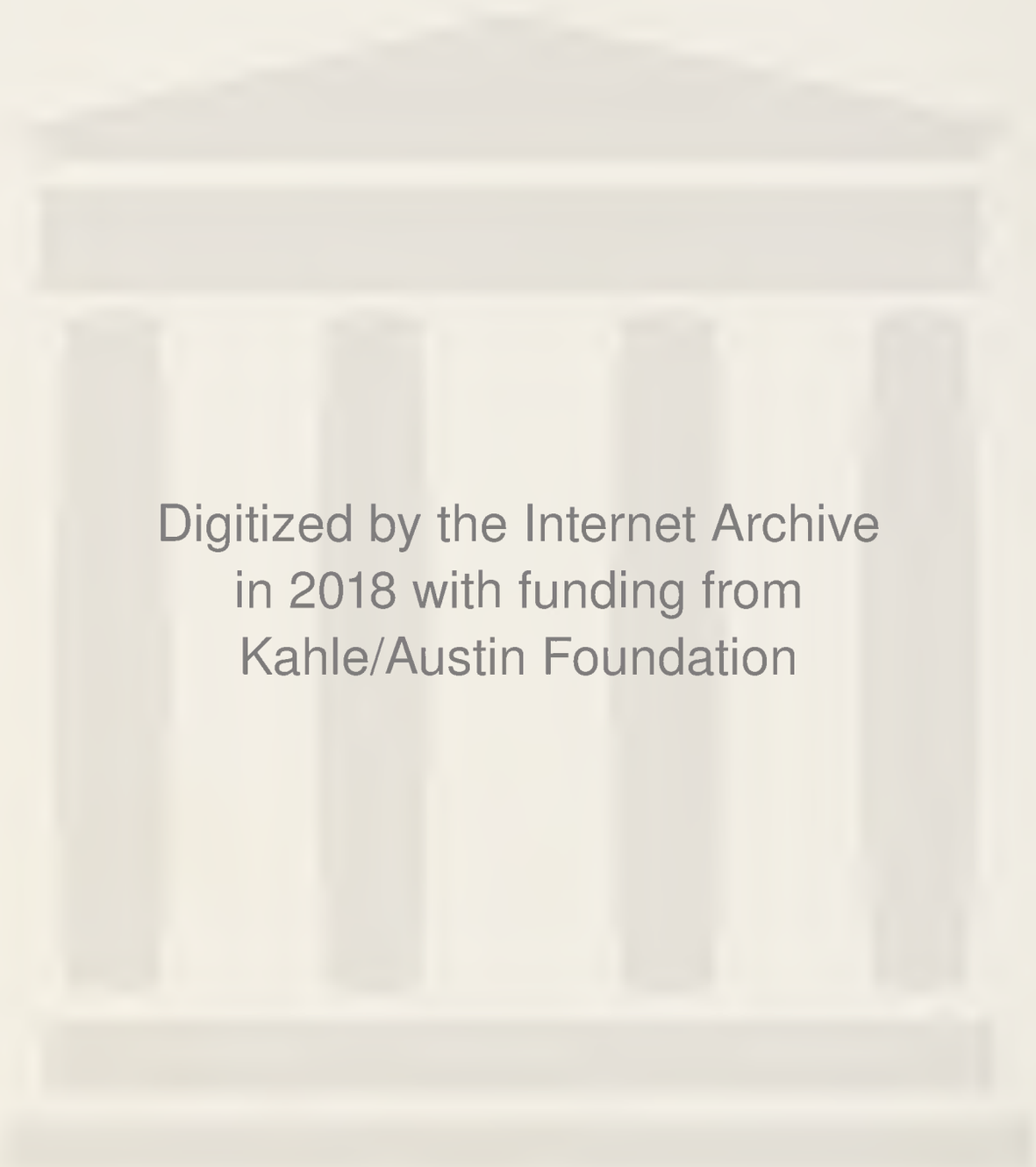
The Biography of
Silk
Carrie Gleason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The Biography of Silk

Carrie Gleason

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Cover: A woman in India places silkworms in straw trays, where they will spin silk cocoons.

Title page: There is a high demand for silk in India, where it is used to make saris, the traditional dress of women.

Contents page: Silk is used to make a variety of finished products, such as silk flowers.

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The Luxury Fabric

Silk is the most desirable fabric in history. Since the ancient Chinese discovered how to make the soft, shimmering fabric, it has been offered as gifts to kings and gods. Silk was such a valuable commodity, or trade good, that the Chinese kept the secret of how it was made for thousands of years so that they would be the only supplier. On dangerous overland trade routes, silk fabric reached Central Asia, India, the Middle East, and Europe. Today, silk is known throughout the world as a luxury fabric.

Silk's Secret

Silk comes from the larva, or caterpillar, of a type of moth. The larva is often called a silkworm. Silkworms spin cocoons made up of a single, long, thread-like **fiber** called a filament. Silk workers carefully unravel the cocoons and twist several silk filaments together to make threads. The silk threads are then woven into fabric. Silkworms are raised on silk farms, which are mainly in Asia. Silkworms have been **domesticated** for so long that it is believed they no longer exist in the wild.

Bombyx mori moths, or silkworms, spin cocoons made of filaments, from which silk goods are made.

In Demand

Silk fabric can be easily dyed brilliant colors, and keeps the wearer warm in winter and cool in summer. Silk fabric is also known for the way it drapes and folds when hung. For these reasons, silk is used to make clothing and home furnishings, such as curtains, bed coverings, and pillowcases. The high **demand** for natural silk has led scientists to develop synthetic, or artificial, silk-like fabrics. These fabrics, such as nylon, are created in laboratories and do not come from the silkworm. Today, synthetic silks are common and cost less to buy, but they have not replaced the high demand for natural silk.

(right) In India, silk is used to make saris, the traditional dress of women. Silk saris use from 15 to 21 feet (4.6 to 6.4 meters) of fabric, which is wound around the body.

Silk threads are dyed brilliant colors to create beautiful embroidered goods.

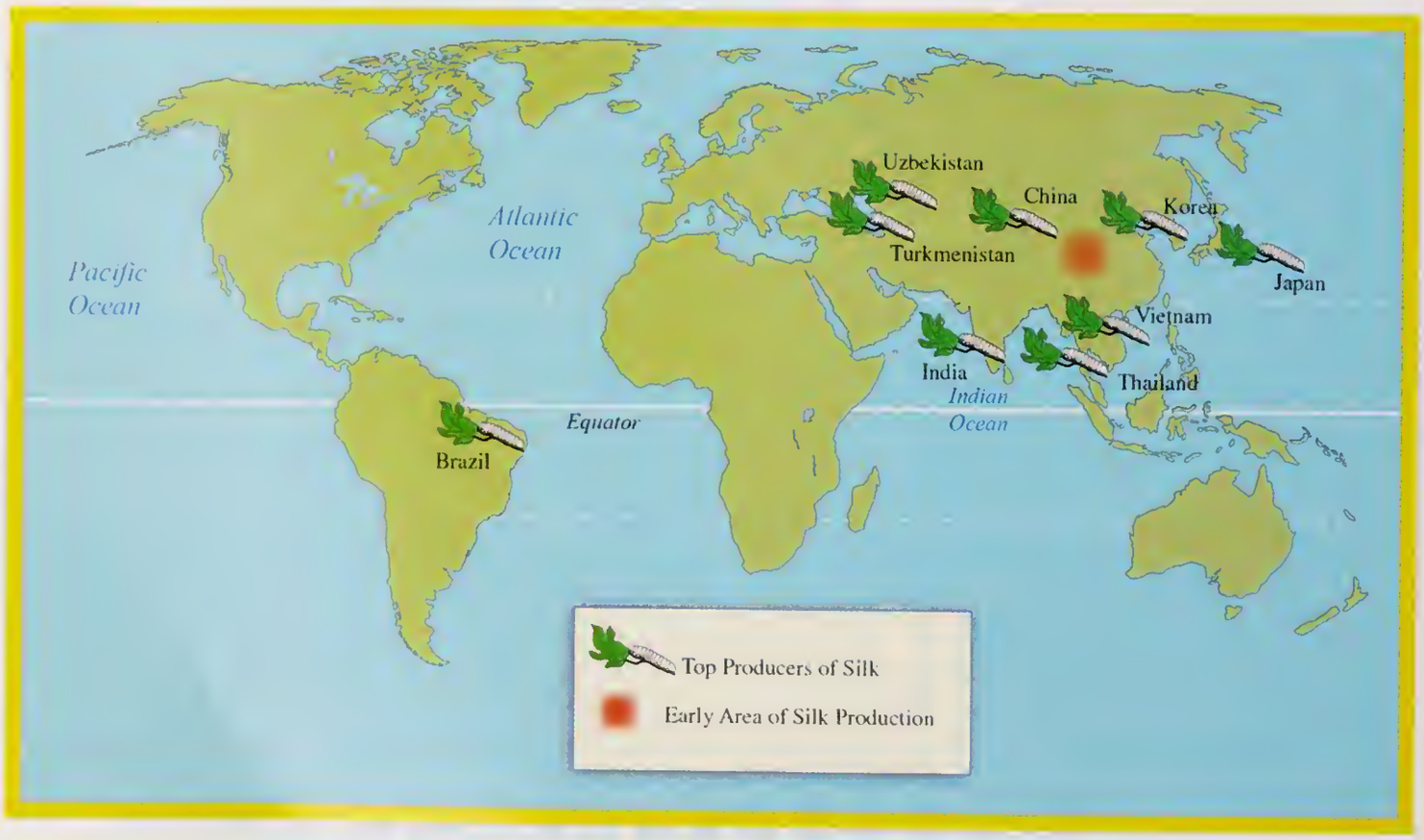
Silk Lands

Silk farming, which is called sericulture, is believed to have first started in China around 3000 B.C. Today, silk is produced in more than 30 countries. Most of the world's raw silk comes from countries in Asia. Raw silk is silk fabric or threads that have not yet been **processed** and made into finished products.

Top Producers

China is the main producer of silk. India, Japan, Korea, and Thailand are other Asian countries that produce a lot of silk. China also exports, or sells to other countries, the most amount of silk. The central Asian countries of Turkmenistan and Uzbekistan, and Brazil, in South America, produce the most raw silk.

(above) Bundles of raw silk at a silk factory in Uzbekistan are ready for export.



This map shows where most of the world's silk is produced today, as well as where sericulture, or silk farming, originated.

Top Consumers

Silk has been a luxury fabric in Europe and North America for many centuries. France, Italy, the United States, and Germany **import** many tons of raw silk each year and use it to make finished silk goods, such as clothing. The biggest demand for raw silk comes from the countries that produce it. India, one of the largest producers of silk, is also the largest importer of raw silk. India cannot produce enough silk to meet the high demand for the fabric within the country.

(right) In Japan, silk is made into kimonos, a traditional dress with wide sleeves.

A Cottage Industry

Silkworm farming is mainly a cottage industry. A cottage industry is work that is done by people at home, using their own equipment and labor. In many Asian countries, village farmers raise silkworms to provide additional income. Sometimes, as silk producing areas grow wealthier, people stop silk farming and instead take jobs that pay them more money.

Silk cottage industries provide people in villages in China with an additional income.

The Silkworm

Silk fabric is made from long thin fibers called filaments produced by silkworms. Over 500 different types of silkworms exist in nature, but the silkworm most commonly used in the silk industry is a moth called Bombyx mori. The Bombyx mori silkworm is used because its silk is smoother and stronger than the silk of other silkworms.

Silkworms move their heads in figure eight patterns when they make their cocoons.

The Life Cycle Begins

Silkworm moths go through four stages of growth, called a life cycle. The first stage in a silkworm's life cycle is the egg. Each female moth lays up to 500 tiny blue-gray eggs. Larvae, or caterpillars, are the second stage. Larvae hatch from eggs by eating a hole through their shells. Young larvae are continuously fed leaves from mulberry trees. As they grow, silkworms molt, or shed their skins, four times. All the while, silk is forming inside their bodies.

Mulberry Trees

White mulberry trees are the main diet of silkworms. The trees are native to central and eastern China, but now grow in Europe and North America, too. White mulberry trees can grow in varying climates, from **tropical** to temperate regions. Temperate regions are areas that do not have extreme hot or extreme cold climates. In spring, white buds form on the trees. The buds grow into leaves of all different shapes and sizes. After about two to three weeks, the leaves are ready to be harvested and fed to silkworms.

Silk Cocoons

Each silkworm has two silk glands in its body that make liquid silk. Glands are specialized body parts that make a substance. A fine silk string is produced by each silk gland. The two strings are joined together to make the filament by a gummy substance called sericin and exit through a body part called a spinneret. A spinneret is a tube-like opening near a silkworm's lower lip. As soon as the liquid silk comes into contact with air, it begins to harden. Silkworms build cocoons to keep safe from **predators** while their bodies change into the pupae life stage.

The Silkworm Moth

A silkworm cocoon is made up of a continuous filament that is up to one mile (1.6 kilometers) long. It takes a silkworm about two days to make its cocoon, which sticks together because of the sericin coating. Inside the cocoon, the larva turns into a pupa. The pupa has a soft brown body with a hard shell. During this stage of its life, the silkworm does not move, but its body changes into a moth. When fully developed into an adult, the moth uses a special liquid in its body to **dissolve** a hole in the cocoon. Through the hole, a fury white winged moth emerges. Adult moths are **bred** to lay new eggs.

Snowy-white adult Bombyx mori moths are nearly blind.

Making Silk

Raising silkworms on farms or in factories takes many hours of careful work, even with modern-day technology. Silkworms must be kept at a constant temperature and their living environments kept clean to prevent disease and encourage them to spin high-quality cocoons.

Raising the Worms

Freshly laid silkworm eggs are usually refrigerated to stop the larvae from developing. The eggs are thawed in **incubators** when the mulberry trees begin to bud. By the time the larvae hatch, the leaves are ready to be harvested. The larvae are hatched on trays, where chopped up mulberry leaves are placed for them to eat. The larvae eat nonstop until they are ready to spin their cocoons. Then silkworm farmers move the larvae to mounting frames made of cardboard, straw, or wood to build their cocoons, which takes up to three days.

Silkworms eat almost continuously until they are ready to build their cocoons.

Mounting frames have small squares in which each silkworm spins its cocoon.

Silk Harvest

Between five and seven days after mounting, the cocoons are harvested. Farmers must be careful to harvest the cocoons at the right time. If the cocoons are harvested too early, the silkworm is still in its larva stage and could be crushed in the cocoon, staining the silk. If left too long, the moth will fully develop and break its way out of the cocoon, tearing the silk filament. One long continuous thread makes stronger silk fabric and is worth more money to a farmer. Farmers carefully load their cocoons on trucks or carts to take them to market. At market, buyers from factories inspect the cocoons for quality and weight. Cocoons with higher weight are more valuable because there will be more silk in the cocoon.

In tropical countries, silkworm cocoons are dried in the sun.

Killing the Silkworm

Cocoons are dried to kill the pupae inside in a process called stifling. Drying also protects the cocoons from **mold**. Cocoons that are dried can be stored up to 12 months in cloth or plastic bags. There are three main methods of drying the cocoons. One is to lay the cocoons on planks of wood in the sun for two to three days. This can only be done in tropical countries, where the sun's rays are strong enough to dry out the cocoons. The cocoons can also be dried using steam. In the steam drying method, the cocoons are placed in baskets and hot water or steam is poured over them to kill the pupae. In factories, steaming takes place in a machine called a steaming chamber. After steaming, the cocoons are left to dry out. In hot-air drying, the cocoons are placed in thin layers in oven-like machines that blow hot air over the cocoons.

Reeling

Dried cocoons are hard. To unravel the silk filament of the cocoon, the sericin that holds it together has to be softened. This is done by boiling the cocoon in water. After it has been softened, the silk is unraveled from the cocoon and reeled. Reeling means winding the filament around a bobbin, or cylinder. Filaments from several cocoons are reeled together to make a strong thread. In the past, and in some countries today, silk is reeled by hand. In other countries, silk is reeled using automatic reeling machines. Workers are careful not to break the thread during reeling.

The silk filaments of the cocoons are reeled.

Wild Silk

Different types of finished silk are made from fibers created by other types of moth larvae. These silks are often called "wild silks" because the worms are not raised on **commercial** farms, but survive in nature. Tussah and Muga are two types of wild silk from India. The larvae from which these silks are harvested eat leaves from willow, beech, oak, and sweetgum trees. This makes the silk they produce colored, instead of white as it is in the Bombyx mori cocoons. Tussah silk, for example, ranges from beige to brown in color. Silkworms that make tussah silk are allowed to develop naturally into adults, and the cocoons are collected after they are empty. Muga silk is valued for its golden color and its strength. The silkworms that make Muga silk are raised only in northeast India.

This woman is wearing clothing handwoven with the golden fibers of Muga silk.

Throwing and Twisting

After reeling, silk undergoes a process called throwing. During throwing, silk threads are twisted to make them strong enough to be woven or knitted, and to prevent the filaments of the reeled silk thread from coming undone. Threads are twisted in several ways to make different types of silk fabric. For example, organzine is a type of silk thread that is made by twisting two or more filaments together in one direction, and then in the other. This creates a strong **warp** thread. Crepe is a type of thread produced by tightly twisting the threads. Crepe threads are woven to make chiffon, a fine, thin fabric used to make scarves and dresses.

A silk worker weaves silk threads on a loom in a factory.

Weaving, Dyeing, and Finishing

Silk is made into fabric by weaving it on looms. Looms are machines that interlock two threads, called the warp and **weft** threads, to create a continuous strip of cloth. One of the earliest types of looms for weaving silk was a drawloom, used in ancient China. The drawloom allowed weavers to create fabric that had complicated, repeating patterns. Today, silk threads are woven in a variety of ways to create different types of fabric. Satin is a type of silk that is woven so that it is shiny on one side and dull on the other. To create colorful finished silk products, silk threads can be dyed before they are woven. Silk threads are also used in embroidery, or intricate stitching that decorates cloth. Silk cloth that has already been woven can also be dyed. Finally, silk fabric goes through the process of finishing. In finishing, cloth is washed in chemicals to change its properties, such as to make it wrinkle resistant or extra shiny. Other finishing processes are done on machines.

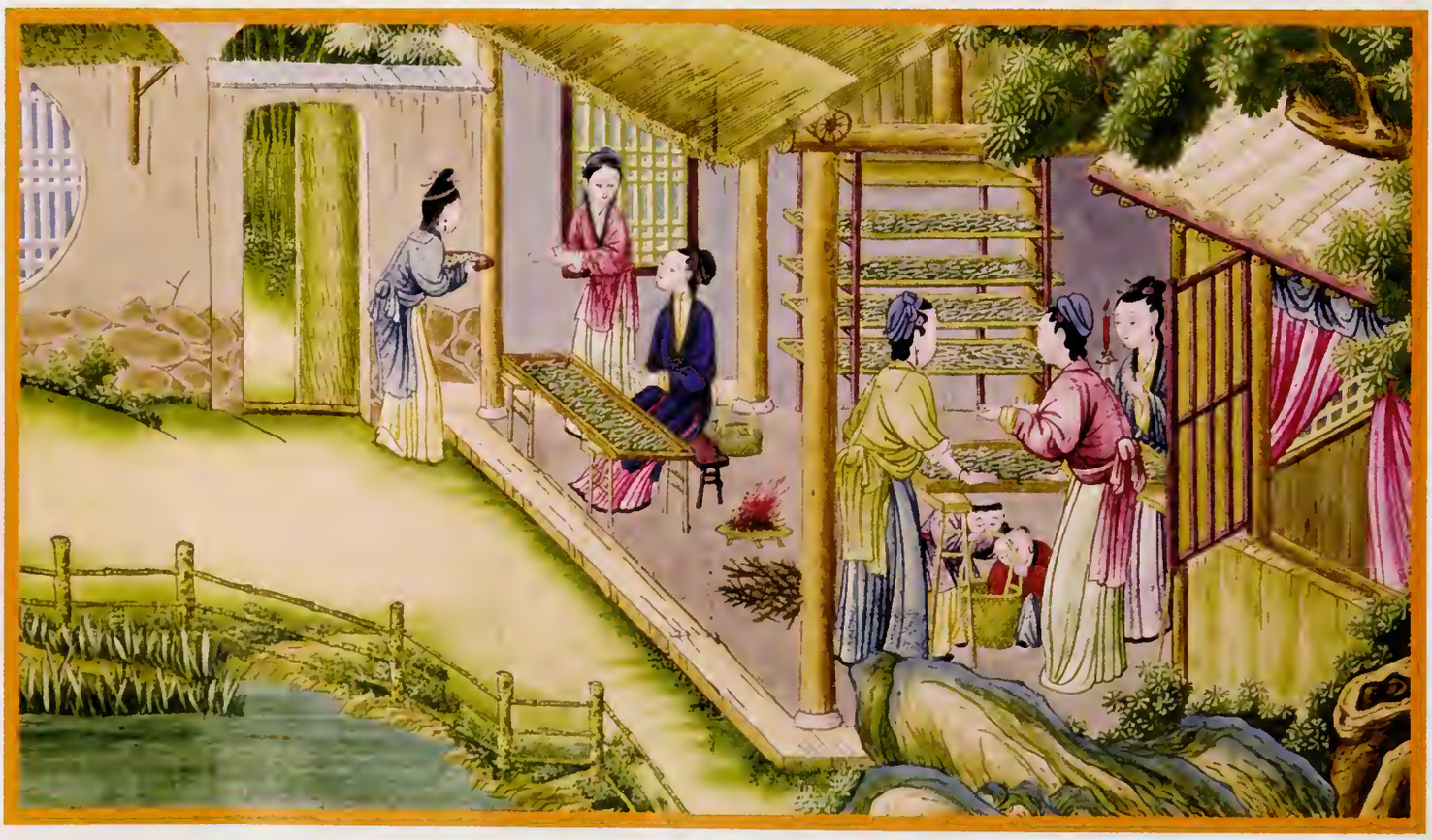
Ancient China's Silk

Silk was first made in China thousands of years ago. **Archaeologists** have found fragments, or pieces, of silk that date back to 3000 B.C. in eastern China. They have also found oracle bones that date back to the era of Chinese history called the Shang **dynasty** (1766 B.C. to 1050 B.C) that tell of human sacrifices to the Silkworm Goddess. The people sacrificed were usually prisoners captured during battles, and were believed to appease the Silkworm Goddess so that she would favor the people with a healthy crop of silkworms.

In ancient China, silk was a valuable fabric that the Chinese traded with other peoples. This painting shows Chinese farmers feeding mulberry leaves to silkworms.

Ways and Customs

Silkworms were raised by Chinese farmers, or peasants, who harvested mulberry leaves and fed them to the larvae. The silkworm cocoons were boiled to kill the larvae and reeled by peasant women in the home. Women also twisted the filaments into thread, wove the threads into cloth, and decorated the silk with embroidery. To make sure that the silkworms were healthy and spun strong silk, customs developed in ancient China. For example, loud noises, such as barking dogs, were believed to upset young silkworms and affect their growth. Peasant women made sure that they were clean, smelled pleasant, and had not eaten chicory before handling the worms so they did not affect the quality of the silk. In some parts of China, these customs are still practiced today.



The Silkworm Goddess's Gift

There are many Chinese legends about how silk production was discovered. According to one legend, Lei Zu, the wife of the legendary Yellow Emperor of China, taught people how to make silk. One day, Lei Zu accidentally dropped a silkworm cocoon into her tea and the hot water from the drink loosened the silk cocoon into one long, soft fiber. Lei Zu decided to weave the fiber into a beautiful piece of silk cloth. Pleased with the result, she then taught the process of silk making to the people of China. Lei Zu is also known as the Silkworm Goddess.

Silk for the Emperor

By 1000 B.C., Chinese society had developed into different social classes. Most people were farmers, but others were emperors, or kings, and nobles. As time passed, laws were made so that only emperors and nobles could wear clothing made of silk. Government administrations were set up to manage silk and silk farming. Wealthy people wore elaborate silk gowns and special clothing for different occasions, such as silk sashes at temples and during ceremonies. Silk was woven into fancy banners and wall hangings for temples. Fans, kites, and toys were also made from silk.

In ancient China, there were twelve symbols that were embroidered onto silk robes that only the emperor could wear. These symbols included dragons, the Sun, and the Moon.

The Silk Road

From China, silk and sericulture spread through a series of trade routes that came to be called the Silk Road. The Silk Road began at the Chinese capital of Changan and led west across Asia, Central Asia, and the Middle East to the shores of the Mediterranean Sea. Along the over 4,400-mile (7,081-kilometer) journey, goods from the **East**, including silk, tea, porcelain, and spices, were exchanged for goods from the **West**, including wine, olive oil, metal weapons, and cloth.

Caravansaries were inns along the Silk Road where merchants ate, washed, and slept. The Tash Rabat caravansary in Kyrgyzstan, in central Asia, was once a popular stop on the Silk Road.

Opening the Silk Road

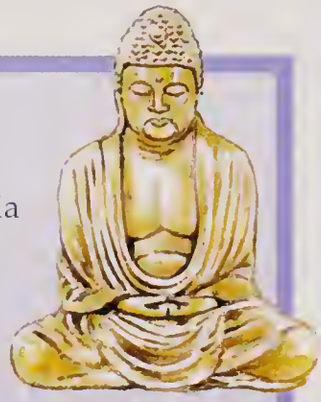
For many years, China was isolated from areas to the west because there were no easy land or sea routes for travel. In 138 B.C., the emperor sent Chinese explorer Zhang Qian to these areas to form an alliance, or military friendship, against invaders with the people living there. Qian failed in his mission, but when he returned to China 13 years later, he told the emperor of the people, customs, and trade goods of the **nomadic** people of Central Asia. When Qian was sent on another journey to form alliances with nomadic people in 119 B.C., he took 300 men, 600 horses, gifts, and trade goods with him. Among the gifts were gold and silk. This is believed to be the first large amount of silk that was traded on the Silk Road. Qian's travels opened up the eastern part of the Silk Road.

Towns and Deserts Past

As the silk trade grew, Chinese peasants began to make silk especially for export on the Silk Road. In Changan, rolls, or bolts, of silk fabric from the Chinese countryside and other trade items were packaged and stored to wait for trade caravans. A trade caravan is a large group of merchants who travel together for safety. After leaving Changan, trade caravans carrying silk traveled to the next major stop on the Silk Road, the **oasis** city of Dunhuang. Situated in the large, sandy Gobi Desert, the city was the last stop before leaving China. Dunhuang became an important trading and supply center for travelers, and grew into a religious center where people from different cultures and religions lived together.

Sixteen miles (25 kilometers) outside of the city of Dunhuang are the Mogao Caves. Many of the 492 caves were used as temples and contain ancient Buddhist statues and paintings. Some of the paintings show merchants trading silk.

Trading Culture



Trade routes from India to the south linked up with the east-west trade routes of the Silk Road. In this way, trade goods from India entered the list of items traded. Ideas, inventions, and religions were also passed on through ancient trade routes. Buddhism, a religion that began in India around 500 B.C., is believed to have been introduced to China by travelers on the Silk Road around 100 A.D. Buddhism became one of the main religions in China.

Buddhism was founded by Buddha, a religious leader from India.

By Camel Through Taklamakan

From Dunhuang, the Silk Road split into different routes through the Taklamakan Desert. The giant moving sand dunes and sand storms made travel through the desert dangerous. The only way to cross was by using camels. Large camel caravans included professional camel drivers and baggage handlers that were hired at oasis towns in the desert. In addition to trade goods, other items were also carried on the backs of camels, including food, water, animal feed, and tents. Each night, caravan members had to set up camp in the desert and take turns standing guard to watch for nomadic robbers.

Caravans traveled as few as ten miles (16 kilometers) and as many as 50 miles (80 kilometers) in a single day. The distance they traveled depended on the weather and the terrain.

Oasis Towns and Mountain Markets

Travel along the Silk Road was made possible by the oasis towns that thrived along the way. At the western edge of the Taklamakan Desert, Kashgar was the last oasis town before leaving the desert behind. After the desert, travelers entered the Pamir Mountains, in what is now Afghanistan and Tajikistan. The Pamir Mountains are made up of several mountain ranges that join in what is called the Pamir "Knot." These are some of the highest mountain ranges in the world. Traders on the Silk Road traded their camels for horses to cross the narrow, snow covered passes and corridors of the mountains. In towns such as Samarkand and Bukara, in present-day Uzbekistan, large bazaars were set up where Silk Road travelers traded their silk and other goods for local items, such as finely woven carpets.

Middle Men

The Silk Road continued through the region that is today called the Middle East. Baghdad, in present-day Iraq, was a center of the **Islamic** world in the late 700s A.D. and a great trading center. Here, ivory, gold, and spices from Africa, spices and cotton from India, pearls from the Persian Gulf, and silk from China were traded. **Arab** merchants carried the silk through Middle Eastern deserts to Damascus and Tyre, which were port cities on the Mediterranean coast. From here, silk and other trade goods were loaded onto ships and sent to Byzantium, in present-day Turkey, or to Rome. Both of these cities were great capitals in Europe.

Brightly colored fabrics for sale at a bazaar in Uzbekistan.

Silk Spreads

The secret of how silk was made spread from China to Korea around 200 B.C. as Chinese people moved into the area. From there, the knowledge spread to Japan, where sericulture became an important industry. In India, wild silks were used to make cloth long before Bombyx mori silkworms were introduced to the area around 400 A.D by a Buddhist monk, or holy man. India traded wild silk and other goods with the ancient Greeks and Romans before this time. Many legends surround the spread of silkworms from China, including that Chinese princesses smuggled the silkworm eggs and mulberry leaves out of China in their headdresses and introduced sericulture to new lands.

This wooden panel painting shows a Chinese princess taking silkworms out of China.

Silk in Europe

By the 1100s, silk production had spread to Europe. In Spain, the silk industry was established by the Moors, Muslims from North Africa who ruled the area after the late 700s A.D. The Moors had learned how to make silk from the Arabs who invaded their homeland, spreading their religion. Silk production is believed to have started in Italy when 200 skilled silk weavers were brought from Constantinople, formerly Byzantium. By the 1300s, the Italian cities of Lucca, Florence, Genoa, and Venice had become centers for silk production.

Italian silk workers sorting cocoons for size and quality. Italian silk merchants supplied England with raw silk to be woven into cloth.

Medieval Silk

Only nobles could wear silk in the Middle Ages. The Middle Ages was a period of European history between 500 A.D. and 1500. During this time, society was divided into strict social classes, or groups, depending on birth and wealth. As merchants and craftspeople began to grow more wealthy from trade, they began to dress in clothing made from expensive, brightly colored silk, just as nobles did. To prevent merchants and craftspeople from being mistaken for nobles, **sumptuary laws** were passed beginning around 1300. In England, sumptuary laws made it illegal for craftspeople to buy and wear silk clothing. The laws also made it illegal for the wives of craftspeople to wear veils made of silk.

Silk Guilds

As silk manufacturing grew in Europe, silk guilds were established. Guilds were organizations made up of craftspeople and merchants who made or sold a certain craft. Together, they set costs for their goods and ensured the high quality of their work. In the Middle Ages, Florence in Italy, and Paris in France had silk guilds. In Florence, the guild for silk workers was called Por Santa Maria, and included many women silk workers. Women who worked in silk were often poor. There were also silk guilds made up of silk merchants, but these were men. Italy's silk industry was famed during the Middle Ages for the great variety of woven silks it produced. The machinery and techniques were closely guarded between different cities. In 1308, in Lucca, Italy, the silk weavers guild declared that any man who shared the city's silk weaving secrets with another city should be killed.

(above) Italy was known for its velvets made from silk during the Middle Ages. Velvet is a type of weave that can be made from any fiber, including silk.

Workers dyeing silk in a French workshop.

Industrializing England

In the mid-1700s, England's silk industry grew, thanks to the work of Thomas Lombe and his brother, John, who opened England's first water-powered silk mill, or factory. In 1717, John Lombe returned from Italy, where he had observed the silk thread throwing machines used there. Throwing machines were used to twist several silk filaments into one stronger thread that could be used for weaving. A year after John Lombe returned from Italy with throwing machine plans, his brother, Thomas, was granted a **patent** for a throwing machine that was powered by a waterwheel. In 1719, the Lombe brothers opened a mill in Derby, England. After Lombe's patent expired, or ran out, silk throwing mills opened up in other English towns.

Changing Textiles

The Industrial Revolution is a period in history that began around 1700 in England. During this time, machines were developed that were powered by water or steam instead of by people. Production sped up and people began to move away from working in mills and factories. Many of the important developments of the time took place in the textile industries, such as cotton and silk making.

Silk weaving in England grew after thousands of Huguenots, or French Protestants, fled France in the late 1600s. Many moved to Spitalfields, a section of London, where they set up silk weaving shops.

The Jacquard Loom

In 1801, Joseph-Marie Jacquard, the son of a silk weaver from Lyons, France, invented a loom that wove silk into patterns. Before the invention of the Jacquard loom, many workers were needed to weave silk in decorative patterns on regular looms. The looms were not immediately accepted by weavers, some of whom feared that the loom would put them out of work. Jacquard looms were also large, so that they required a separate workroom. By 1812, there were 11,000 Jacquard looms in use in France. From France, the Jacquard loom spread to other European countries.

The Jacquard loom used a series of punched cards to control the pattern of the weave.

The first silk stockings were made in the 1500s. Before this time, stockings were made from wool, a thick, scratchy fabric.

France and Pasteur

By the 1600s, France had become a leader of silk production in Europe. In 1850, disaster struck the sericulture industry. The silkworms developed black spots and died or were unable to spin their cocoons. The French government hired scientist Louis Pasteur to investigate the cause. After two years studying the worms and their environment using a microscope, Pasteur found that the silkworms were infected with the diseases pebrine and flacherie. Pasteur's groundbreaking theories on contagion in diseases saved the silkworm industry in France and the rest of Europe when he bred only moths free from disease.

America's Silk Industry

Since the beginning of English **colonization** of North America in the 1600s, attempts had been made to raise silkworms. England's king, James I, had mulberry trees sent to the colonists at Jamestown, Virginia, the first permanent settlement, founded in 1607. King James hoped that the colonists would succeed in raising silkworms so that they could supply England with the raw material it needed for its silk industry.

In 1869, during a cotton fabric shortage, gypsy moths were introduced to North America. It was believed that the caterpillar of the moth could be used to supply silk. The experiment failed and today gypsy moths are viewed as pests.

Mulberry Craze

In the early 1830s, the U.S. government put out a brochure that encouraged people to raise silkworms. At the time, Americans were looking for new cash crops. Many people were also looking for new ways to make money quick. One of the ways they tried was by growing mulberry trees. By 1839, speculation had hit the industry. Speculation is when people invest in something, such as mulberry trees, in order to resell it for a profit during high demand, and not to make any finished product. Many people began buying and selling mulberry trees, until a harsh winter in 1839 damaged the mulberry trees. The prices for mulberry trees dropped and some farmers lost a lot of money. The earlier enthusiasm for a sericulture industry in America dropped off.

New York was the center of the fashion industry in the United States. Silk was a luxury fabric used in the fashion industry, especially to make dresses.

Silk City, U.S.A.

Using raw silk imported from Asia, silk manufacturing grew in the eastern United States after 1865, when tariffs, or taxes, on goods imported from Europe were raised. At this time, there was a high demand for silk in the **fashion industry**. By 1880, silk mills in Paterson, New Jersey, were producing almost half of America's silk. Paterson was built on the Passaic River, which provided power for the town's silk mills and many other types of mills. Paterson was also close to New York, which was where raw silk imported from China, Japan, and Italy entered the United States. Skilled silk workers immigrated to Paterson from Italy, France, Germany, and England to work in the mills.

Workers march in New York City in support of the Patterson silk strike of 1913.

Striking Silk Workers

For ten hours a day, five and a half days a week, workers toiled in the silk mills in Paterson, New Jersey. Some of the factories were dyeing mills, where workers dyed silk thread and fabric in large vats of hot water and chemicals. Other mills were weaving mills, where workers used looms to weave silk cloth and ribbon. In 1911, silk mill owners tried to change their work system so that weavers ran four looms at a time, instead of two. Fearing that this would create a loss in jobs and quality of woven cloth, 800 silk weavers went on strike in January 1913. Soon after, they were joined by workers from 300 other types of mills in the town. The strike ended seven months later, by which time silk mill owners had lost an estimated $10 million in profits because of the strikes.

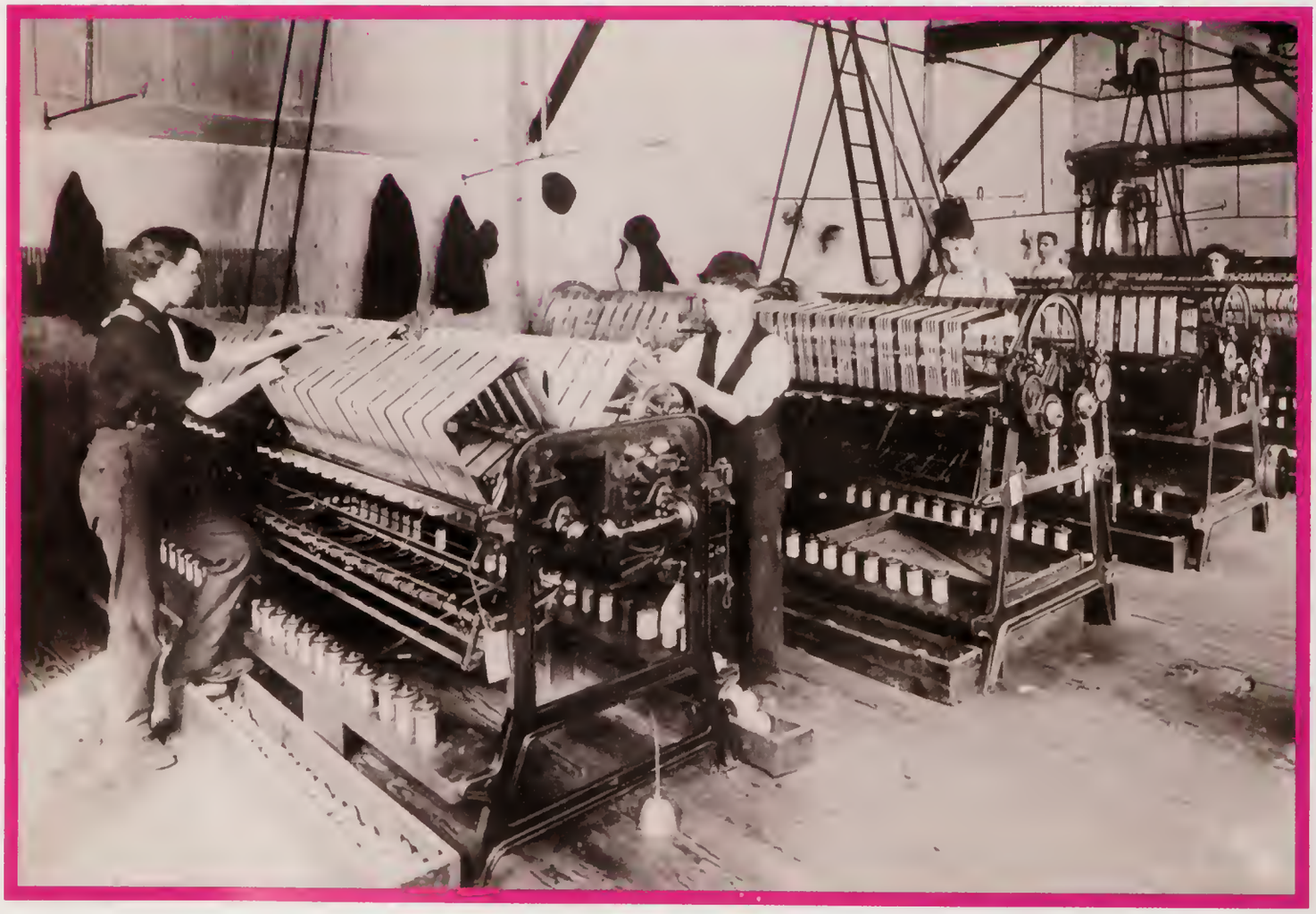
Young Textile Workers

Today, silk is made in many Asian countries. In some countries, raising silkworms is done by families in villages. Often, children are expected to help their families care for the worms.

Children in the Mills

Child labor was historically used in silk and other textile mills in England and the United States. Children were hired by mill owners because they worked for lower wages and were less likely to strike. In England, children were purchased from orphanages and workhouses and forced to work in textile mills. Mill owners fed and clothed the young workers, who were referred to as "apprentices" but did not pay them wages and, in some cases, refused to let them leave the mills. Children also worked long hours and performed dangerous jobs involving machinery. Throughout the 1800s, laws were passed in England and in the United States to try to restrict child labor in textile mills.

Teenage boys reel silk at the New Jersey Worsted Spinning Company. Children were employed to work in silk mills in Paterson, New Jersey, and in other silk mills in North America and Europe.



(above) In 2005, hundreds of child laborers were rescued in Bombay, India, and returned to their homes. The children were working in factories that manufacture leather, steel, and silk embroidered goods.

India's Child Workers

Human rights organizations report that children work in India's silk factories today. Children under the age of 14 are said to work as many as 84 hours per week making silk thread. They do jobs such as washing the silk in steamy water to loosen the cocoons. According to some reports, the children are badly burned from their work and some are beaten by their employers. The children work under a system called bonded labor, which means that their parents have borrowed money from a factory owner and the children have to work until the debt is repaid. India's government is working to end bonded child labor in its silk factories.

(right) A young worker embroiders with silk thread in a Chinese factory.

Silk Uses

The main use of silk today is in the fashion industry. Many items of clothing are made out of silk, including shirts, dresses, and pants. Items made only from natural silk are more expensive to buy than goods made of silk blended, or combined, with other natural fabrics, such as cotton, or with synthetic materials.

(left) This evening gown is made of white silk.

Synthetic Silk

Synthetic silk is fabric made from human-made fibers. Alchemists, or early chemists, tried to make silk from other materials in the Middle Ages. Rayon and nylon are two types of synthetic fabrics available today that are similar to silk in strength and **luster**, and can be used in place of natural silk. Rayon was invented in the early 1900s by Count Hillarie de Chardonnet, a scientist who worked with Louis Pasteur to solve France's silkworm problems. Nylon, made from petroleum, was invented by a chemical company called DuPont in the 1930s. Nylon was invented by Wallace Carothers, the scientist who also helped develop synthetic rubber. In 1929, nylon was introduced to the public at the New York World's Fair as the material used to make women's stockings. Nylon stockings were an instant success because they were much cheaper to buy than those made of silk.

(right) Silk-screen printing, or serigraphy, is a method of printing designs by squeegying paint or ink over a silk screen.

Silk Foods

In some Asian countries, silkworm pupae are eaten. Silkworm pupae are a source of protein. They are sold preserved in tin cans and are fried with spices before being eaten. In the past, silkworm pupae were eaten in villages in China during times of famine. Today, silkworm pupae are sold in restaurants. In Japan, waste silk has also been ground into a fine powder and made into noodles and candy.

(above) The first parachutes were made of silk in the 1700s. There was a boom in silk parachute manufacturing during World War I. Parachutes continued to be made from silk until synthetic fibers were developed during World War II.

Silk in Medicine

Silk is made out of protein. Animals and humans both need protein to be healthy. This makes silk good for use in medicine. Silk is made into artificial tendons and ligaments. Tendons are **tissues** inside the human body that connect muscles and bones, and ligaments are tissues that connect bones to bones. Silk has long been used to make sutures, or stitches used to sew up wounds in the skin. Sutures made from silk are specially manufactured.

(above) **Ppeondaegi**, *or boiled silkworm pupae, is a popular treat sold by street vendors in Korea.*

The Future of Silk

Silk is a natural fiber that is a **renewable resource**, which means that, with proper care, the supply of silk will not run out. Scientists are doing research to find new ways of using silk. They also try to breed silkworms that will not be affected by diseases and temperature changes. Research is also being made into developing new kinds of silkworms that will eat other foods besides mulberry leaves. In some laboratories, scientists are developing silkworms that produce naturally colored silks, so there will be no need to dye the threads.

Silk and the Environment

Growing mulberry trees to feed the silkworms is good for the environment because the trees can grow in soil that is too poor to grow other food crops. Like all trees, mulberry trees help protect against soil erosion, or keep the soil in place so that it is not washed away by the wind and rain. Some people argue that silk making harms the environment because so much water and chemicals are used in manufacturing. Water is used to boil the cocoons and to degum, or wash the sericin from, the filament. Almost one ton of water is used to make one ton of raw silk.

Dr. Gerard Chavancy is a French scientist and one of the world's leading silkworm experts. Here, Dr. Chavancy performs experiments on silkworms in his laboratory.

Animal Rights

Some people argue that silk production is cruel to silkworms because they are killed before they live out their entire life cycle. Silkworms have been domesticated for so long that scientists believe the moths could no longer survive in the wild without human help. For many years, silkworms that were not healthy or did not create the best silk were killed before they could breed. As well, only moths with small, weak wings were allowed to breed. This was so that the moths did not fly off to lay their eggs somewhere else, where farmers could not harvest the cocoons. Today, silkworm moths can barely fly at all. The silkworms' legs have also become very weak over the years because they no longer have to walk to find food.

(above) "Peace Silk" is a method of producing silk without killing the silkworm moth. The moths are allowed to emerge naturally from the cocoon. The broken silk fibers are then spun like other cloth fibers.

Research is being done into uses for the waste pupae. It may one day be made into oil.

Glossary

archaeologist A person who studies ancient cultures

Arab A person from present-day Saudi Arabia

bred Joined together to create offspring

colonization The period in which a country imposes its rule over another and sends settlers to live there

commercial For a profit

demand The amount wanted by buyers

dissolve To cause to fade away

domesticate To take from the wild and change the behavior of

dynasty A ruling family

East A term that refers to all the countries of Asia

fashion industry The businesses involved in designing and manufacturing clothing

fiber A thin strand

human rights organization A group of people who investigate and make others aware of the rights of people living in certain areas

import To buy in from another country

incubator An artifically heated container for hatching eggs

Islam The religion based on the teachings of the prophet Muhammad

luster Brightness, or how much light is reflected off an object

mold A fungus that grows on damp things

nomadic Moving from place to place

oasis An area in a desert that has water and vegetation

patent Legal rights as the inventor of something

predator An animal that hunts another

processed Changed from its original form and made into something else

Protestant A branch of Christianity that split from the Roman Catholic Church in the 1500s

renewable resource A resource is something found in nature that people use, such as wood, water, and oil. Renewable resources can be replenished by nature

sumptuary laws Laws passed to restrict the kinds of clothing worn by people of different social classes, or rank

tissue Groups of cells that perform a similar function

tropical Regions of the world that receive the most sunlight just north and south of the equator

warp The lengthwise yarn on a loom

weft The widthwise yarn on a loom

West A term used to describe the cultures of Europe and North America

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